1,065,340

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,065,340

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Int. Cl.:—B 01 d // B 04 b

COMPLETE SPECIFICATION

Centrifugal Separator

We, BIRD MACHINE COMPANY, a corporation organised and existing under the laws of the Commonwealth of Massachusetts, United States of America, of South Walpole, Massachusetts, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a centrifugal separator for separating solid particles from liquid slurry and pertains more specifically to such a separator having a helical conveyor in combination with an imperforate frustro conical bowl or combination cylindrical and conical bowl for initial separation of solids from the liquid by drainage and a screen bowl for final separation or drainage.

Centrifugal separators having screen bowls which combine imperforate sections with perforate sections and having conveyors for moving the solids axially of the bowl have been previously proposed but they have been unsatisfactory in that the screens have had a tendency to become rapidly blinded by the finer portion of the solid particles, leading to the retention of an excessively large proportion of liquid in the solids discharge as well as to the necessity for frequent interruption of operation in order to clear the screens.

An object of the present invention is to provide a centrifugal separator for slurries in which the initial drainage of liquid from solid particles takes place in an imperforate conical portion of the bowl and the final drainage takes place in a screen portion of the bowl.

Accordingly the present invention provides a centrifugal separator for separating solid particles from the liquid portion of a slurry comprising a rotatable bowl including an imperforate truncated conical inner surface connected at its smaller end with the inlet end of a cylindrical portion extending coaxially therefrom having at least one screen in its wall and having a solids discharge end opposite said inlet end, a helical conveyor coaxially mounted for rotation within said bowl, means for introducing said slurry into said bowl in advance of the inlet end of said cylindrical screen portion, means for rotating the bowl and the conveyor in the same sense at slightly different speeds to cause the solids in said slurry to deposit on the inner surface of the bowl and to advance the solids deposit in one direction along said conical surface toward the discharge end of said screen portion and means for removing the liquid portion of said slurry to maintain the depth of liquid within said bowl at such a level that the surface of the liquid intersects the conical surface at a distance from the inlet end of said screen portion, measured along the axis, equal to at least 15% of the diameter of the larger end of said conical surface.

In order that the invention may be clearly understood, some preferred embodiments thereof are now described with reference to the accompanying drawings.

In the drawings, Fig. 1 is a view in side elevation partly broken away and in section showing one embodiment of the present invention,

Fig. 2 is a view in section taken along line 2 — 2 of Fig. 1;

Fig. 3 is a view in vertical section partly broken away showing another embodiment of the invention, and,

Fig. 4 is a view in vertical section partly broken away showing still another embodiment of the invention.

The embodiment shown in Fig. 1 of the drawing comprises a base 10 carrying at one end a bracket arm 12 supporting a fixed feed pipe 14 through the inlet end 16 of which is introduced the slurry which is to be separated into its solid and liquid components. The centrifuge bowl indicated generally by the numeral 18 is mounted for rotation about a central axis. It is supported at its right hand or inlet end as shown in Fig. 1 by means of a flange

20 secured to trunnion 22 rotatably supported in pillow block 23 bolted to frame 10. A drive sheave 24 is secured to the free end of trunnion 22 and, when connected to any suitable source of power (not shown) serves to rotate bowl 18 at the desired rate of speed. The left hand end of bowl 18 as seen in Fig. 1, is similarly supported by means of flange 26 which in turn is secured to trunnion 28 mounted for rotation in pillow block 30 bolted to base 10.

Mounted concentrically within bowl 18 is conveyor 32 having helical flights 34 secured to a hollow cylindrical core 36. Core 36 is mounted at its right hand end on a flange 38 secured to a hollow shaft 40 mounted for rotation concentrically within trunnion 22 by means of bearings 42, 44. Inlet pipe 14 extends through the center of hollow shaft 40 into the interior of hollow core 36 which is provided with apertures 54 to permit the feed slurry to pass from feed pipe 14 into the interior of bowl 18. A pipe 15 for wash water extends concentrically through the center of feed pipe 14 and is mounted for sliding movement lengthwise to bring the outlet 17 at its inner end into registration with any one of the several chambers within hollow core 36 formed by annular baffles 19, 19. The wash water may thus be directed to pass through any one or more of nozzles 21, 21 in the wall of core 36. The left hand end of the hollow core 36 of conveyor 32 is secured to flange 46 which in turn is fixed to shaft 48 mounted for rotation concentrically within trunnion 28 by means of bearings 50.

Both trunnion 28 and shaft 48 are connected to differential gear unit 52 arranged so that when bowl 18 together with trunnion 28 is driven at the usual speed of several hundred RPM, shaft 48 together with conveyor 32 will be driven in the same direction as the bowl at a speed which differs from that of the bowl by only 10 to 40 RPM. This arrangement, which is conventional in solid or imperforate bowl centrifuges causes the conveyor to advance any layer of solid particles deposited upon the inner surface of the bowl from the inlet end of the bowl toward the left hand or solids discharge end as seen in Fig. 1.

A casing 56 is mounted around the outside of bowl 18 and is provided with a solid discharge opening 58 and liquid discharge openings 60, 71 and 73. Annular baffles 62, 64, 66 fixed to the inside of casing 56 mate with corresponding baffles 62^1, 64^1, 66^1 secured to the outer face of bowl 18 and serve to maintain the solid discharge separate from the liquid discharge. Additional baffles 67 are provided inside the casing 56 to segregate the liquid (wash liquid or mother liquor) discharged from various parts of the screen portion. Baffles 67 are interrupted in one portion of their periphery and a gutter 69 is slidably mounted in the interrupted portion to collect the discharge from any desired number of the compartments formed by baffles 67 and to provide any desired division of the discharge between outlets 71 and 73 in casing 56. If desired, provision may be made for recirculating the liquid issuing from one or both outlets 71 and 73 through pipe 15.

Bowl 18 includes a portion 68 having an imperforate truncated conical inner surface tapering in diameter from right to left as seen in Fig. 1 and connecting at its smaller end with the inlet end of cylindrical screen portion 70. The screen portion 70, the wall of which is provided with one or more perforate screens adapted to pass liquids but to retain the particulate solid materials separated from the feed slurry, extends from its inlet end through which the solid material is introduced by means of conveyor 32 to its opposite solids discharge end where it is provided with solids discharge apertures 72, 72. Conveyor 32 extends through both conical portion 68 and screen portion 70 and is preferably continuous although a conventional conveyor having interrupted flights may also be used. Conventional double or triple helical conveyors may also be used, each extending through both conical portion 68 and screen portion 70.

A liquid overflow port 74 is provided in flange 20, arranged so that as the liquid slurry is introduced into bowl 18 it is formed into a pool by centrifugal force against the imperforate inner surface. The surface of the pool intercepts the conical surface of the bowl portion at a zone A, the location of which is determined by the position of the overflow port 74. In order to minimize blinding or plugging of the screen portion 70, it has been found that zone A must be spaced from the smaller end of the conical portion 68, where it connects with the inlet end of the screen portion 70, by a distance, measured along the axis of the device, which is equal to at least 15 percent of the inner diameter of the bowl 18 measured at the larger end of the conical portion 68. Such spacing provides for adequate initial drainage of the liquid from the solid particles by the action of the helical conveyor urging the bed of solid material forwardly out of the liquid pool. Preferably the diameter at the smaller end of the conical portion 68 is from 65 to 95 percent of the diameter at the larger end for best results. The minimum spacing required between zone A, that is the margin of the liquid pool, and the inlet end of the screen portion 70 of the bowl for satisfactory operation may also be defined as the spacing provided by controlling the total volume of the liquid pool (including any solids contained therein) to no more than 25 percent of the total volume within the imperforate portion of the bowl.

The size of the apertures in the screen portion 70 of the bowl may be varied depending upon the nature and particle size of the solids which are separated from the liquid feed slurry, generally being controlled so that a

minimum of fine particles is permitted to pass through the screen. If desired, a plurality of spray nozzles 76, 76 connected to a suitable header or manifold 78 may be mounted on one part of casing 56 radially outwardly of screen portion 70; by supplying water or steam to the manifold when desired the nozzles may be used to clean the screen portion 70.

In operation of the device the bowl 18 and conveyor 32 are driven from sheave 24 at appropriate differential speeds while the liquid slurry is introduced through inlet opening 16 and flows through inlet pipe 14 thence through apertures 54 in core member 36 to form a liquid pool by centrifugal force against the inner surface of the imperforate conical portion 68 of bowl 18. As the level of liquid within the pool rises above the margin of liquid outlet 74 the liquid overflows into casing 56 thence through liquid discharge opening 60 in the bottom of the casing. The solid particles in the slurry, being of greater density than the liquid, form a layer directly against the inner surface bowl 18 and are urged along it by flights 34 of conveyor 32 from right to left as seen in Fig. 1. As the layer of solid particles emerges from the liquid pool and is further advanced along the conical inner surface of the bowl toward the inlet end of screen portion 70, liquid continues to drain from it by centrifugal force and to flow back toward the liquid pool. This initial drainage of a large proportion of the liquid from the solid particles changes the flow characteristics of the mass of solid particles so that as it continues to be advanced by conveyor 32 across the screen portion 70 of the bowl, tendency of the apertures in the screen to become plugged or blinded by the solid particles is minimized, and additional and greater drainage of the liquid from the solid particles is achieved. Wash liquid or vapor (e.g. water or steam) may be introduced through pipe 15 to wash and/or dry the solid particles passing across screen portion 70. The mass of solid particles having been effectively washed and separated from the liquid portion is discharged through apertures 72, 72 into casing 56 from which it passes downwardly through solids discharge outlet 58. The liquid portion or portions is discharged through outlets 60, 71 and 73.

While the theory of operation of the present invention may not be fully understood and the applicants do not wish to be bound by the following explanation, it is believed that the great effectiveness of the device of the present invention in separating liquid from solid particles and the reduction of the tendency for the screen portion to become blinded or plugged during operation are the result of the initial drainage of a large portion of the liquid away from the mass of solid particles while the latter are still retained within the imperforate portion of the bowl. The fact that there is less liquid present when the mass of solid particles reaches the screen portion means that there is less tendency for the liquid to "float" or convey the smaller particles to or through the screen, consequently less loss of solids with the liquid and less tendency for the screen portion to become plugged.

In another embodiment of the invention as shown in Fig. 3 of the drawing the bowl 80 consists of an imperforate conical portion 82 which merges with a conical screen portion 84 of matching taper. In this embodiment the entire bowl is conical in configuration and possesses no cylindrical portion at all. However, for satisfactory operation it is essential that the liquid overflow outlet be arranged so that the margin of the liquid pool at zone A where it terminates on the inner surface of imperforate conical portion 82 be spaced from the inlet of screen portion 84 by a distance, measured along the axis of the centrifugal separator, equal to at least 15 percent of the inside diameter of the conical portion 82 at its larger end. The spacing may also be defined as that provided by controlling the total volume of the liquid pool to a maximum of 25 percent of the total volume contained within the imperforate portion of the bowl. As in the embodiment shown in Fig. 1, the inner diameter at the smaller end of the imperforate conical portion 82 should be for best results, from 65 to 95 percent of the inner diameter at the larger end.

In the embodiment shown in Fig. 4 of the drawing bowl 90 consists of an imperforate conical portion 92 connected at its smaller end with a screen portion 94 which is conically divergent outwardly toward the solid discharge end. In this embodiment conveyor 96 terminates at the inlet to screen portion 94, the divergence of the screen portion together with centrifugal force being sufficient to convey the layer of solids along the length of the screen portion 94 without the help of a conveyor. However, it may be desirable to extend the conveyor into the screen portion in some cases. The operation of this embodiment is otherwise the same as that of the embodiments of Figs. 1 and 3, and the minimum spacing between the margin of the liquid pool and the inlet of screen portion 94 is also the same.

The above described embodiments of the invention provide a centrifugal separator in which the level of the liquid pool within the bowl is controlled to maintain its margin on the imperforate conical surface of the bowl spaced from the inlet into the screen bowl portion by a substantial distance along the axis of the bowl to promote initial drainage of the bulk of the slurry liquid from the solid particles, relying on the screen bowl portion only for drainage of the remaining liquid from the solid particles.

WHAT WE CLAIM IS:—

1. A centrifugal separator for separating solid particles from the liquid portion of a

slurry comprising a rotatable bowl including an imperforate truncated conical inner surface connected at its smaller end with the inlet end of a cylindrical portion extending coaxially therefrom having at least one screen in its wall and having a solids discharge end opposite said inlet end, a helical conveyor coaxially mounted for rotation within said bowl, means for introducing said slurry into said bowl in advance of the inlet end of said cylindrical screen portion, means for rotating the bowl and the conveyor in the same sense at slightly different speeds to cause the solids in said slurry to deposit on the inner surface of the bowl and to advance the solids deposit in one direction along said conical surface toward the discharge end of said screen portion, and means for removing the liquid portion of said slurry to maintain the depth of liquid within said bowl at such a level that the surface of the liquid intersects the conical surface at a distance from the inlet end of said screen portion, measured along the axis, equal to at least 15% of the diameter of the larger end of said conical surface.

2. A centrifugal separator as claimed in claim 1 in which the diameter of the smaller end of said conical surface is from 65 to 95% of the diameter of the larger end.

3. A centrifugal separator as claimed in claim 2 in which said conveyor comprises a continuous helix extending within both said conical surface and said cylindrical screen portion.

4. A centrifugal separator for separating solid particles from the liquid portion of a slurry comprising a rotatable bowl including an imperforate truncated conical inner surface connected at its smaller end with the inlet end of a cylindrical portion extending coaxially therefrom having at least one screen in its wall and having a solids discharge end opposite said inlet end, a helical conveyor coaxially mounted for rotation within said bowl, means for introducing said slurry into said bowl in advance of the inlet end of said cylindrical screen portion, means for rotating the bowl and the conveyor in the same sense at slightly different speeds to cause the solids in said slurry to deposit on the inner surface of the bowl and to advance the solids deposit along said conical surface in one direction toward the discharge end of said screen portion, and means for removing the liquid portion of said slurry to maintain the depth of liquid within said bowl at such a level that the volume of the liquid pool within the bowl is not more than 25% of the total volume of the space within the bowl up to the inlet end of said screen portion, and the diameter of the smaller end of said conical surface is from 65 to 95% of the diameter of the larger end.

5. A centrifugal separator as claimed in any of the preceding claims additionally comprising means mounted radially outwardly of said screen portion for applying cleaning fluid thereto.

6. A centrifugal separator substantially as hereinbefore described with reference to Figs. 1 and 2, 3 or 4 of the accompanying drawings.

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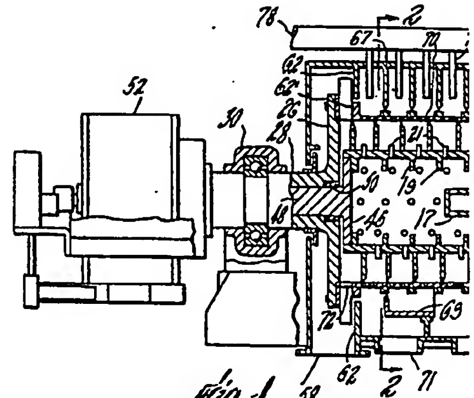
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Fig. 1.

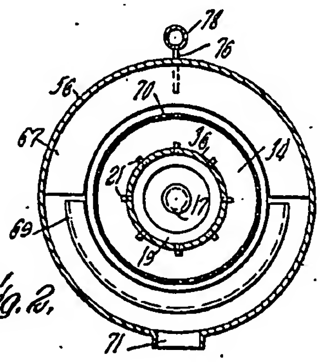
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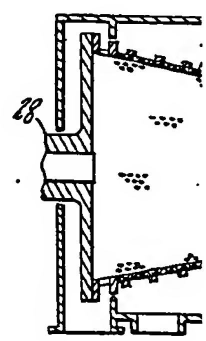
Fig. 2.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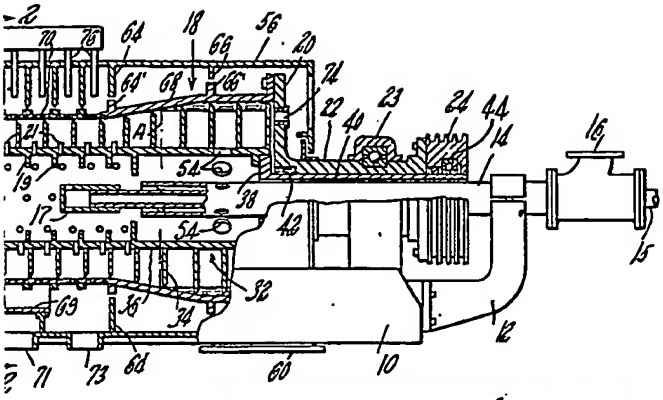

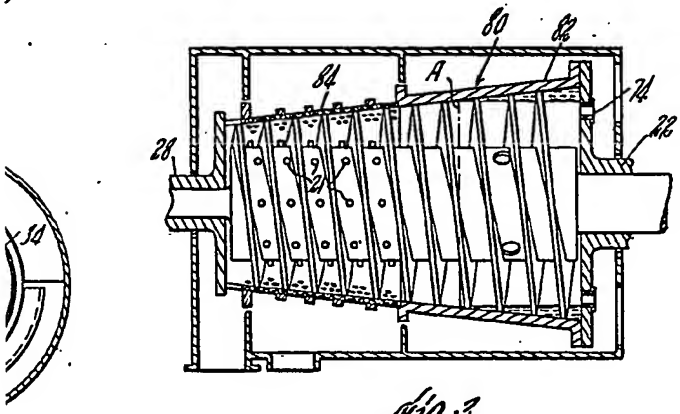

Fig. 3.

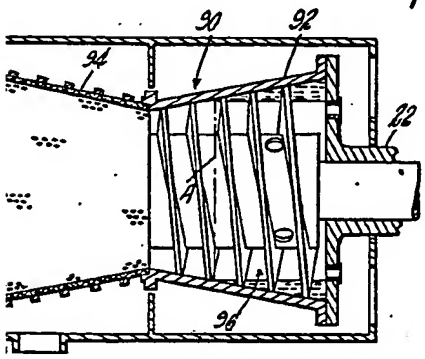

Fig. 4.

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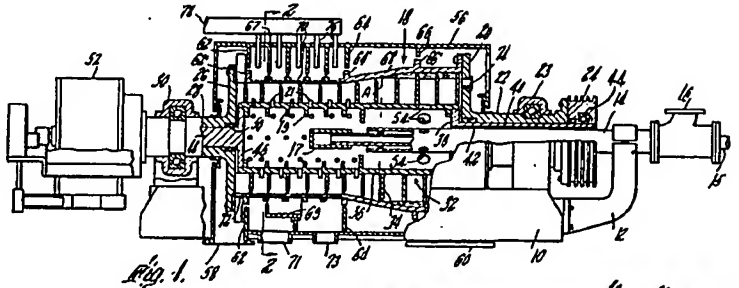

Fig. 1.

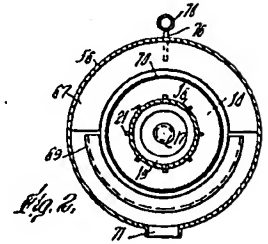

Fig. 2.

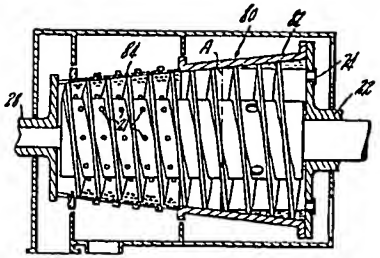

Fig. 3.

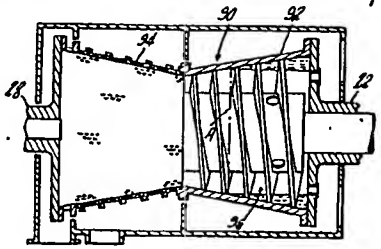

Fig. 4.